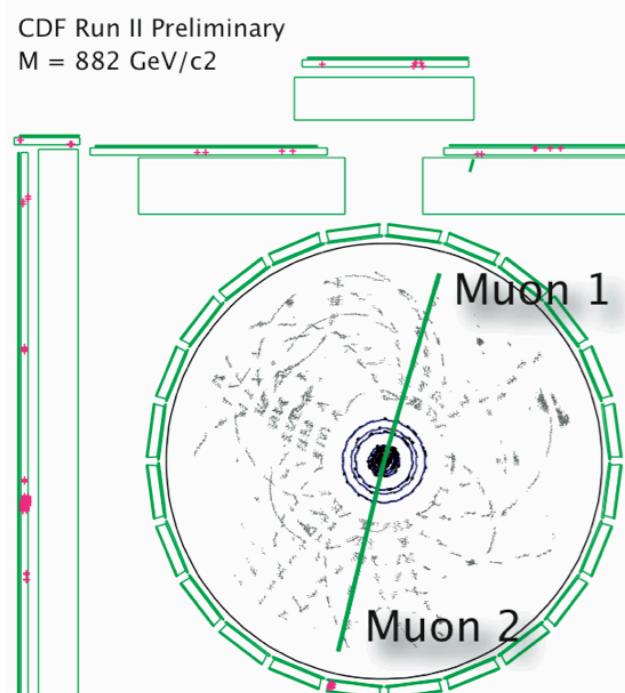
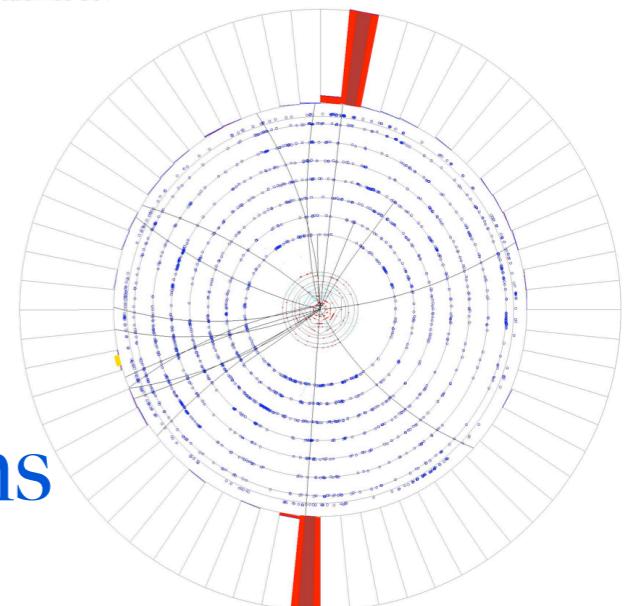


Searches in dilepton and diphoton final states at the Tevatron



Run 233604 Evt 7403139 Tue Jun 12 00:44:32 2007
ET scale: 296 GeV



Chris Hays,
Oxford University

for the CDF and DØ Collaborations



35th International Conference on High Energy Physics
Paris, France, 24 July, 2010

Experimental motivation

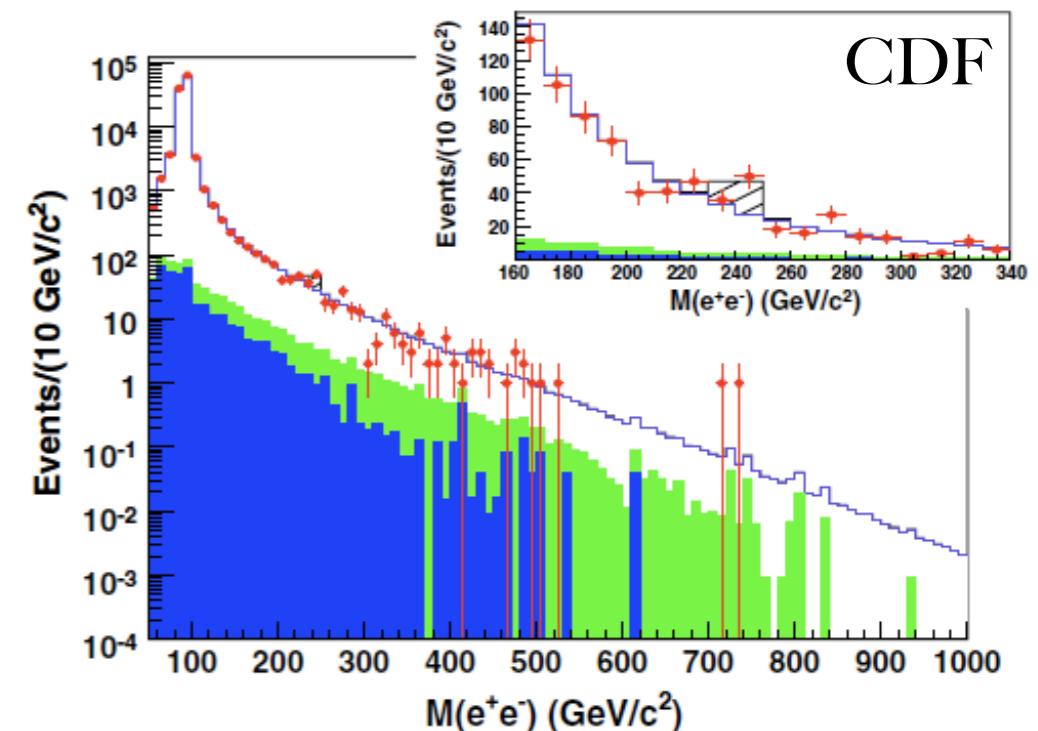
- * Diphoton and dilepton searches provide a clean, model-independent probe for new particles

- * Excellent detector resolution

- * CDF dimuon mass resolution: $\approx 15\%$ at 1 TeV
- * CDF dielectron mass resolution $\approx 2\%$ at 1 TeV

- * Unambiguous mass peaks separable from background

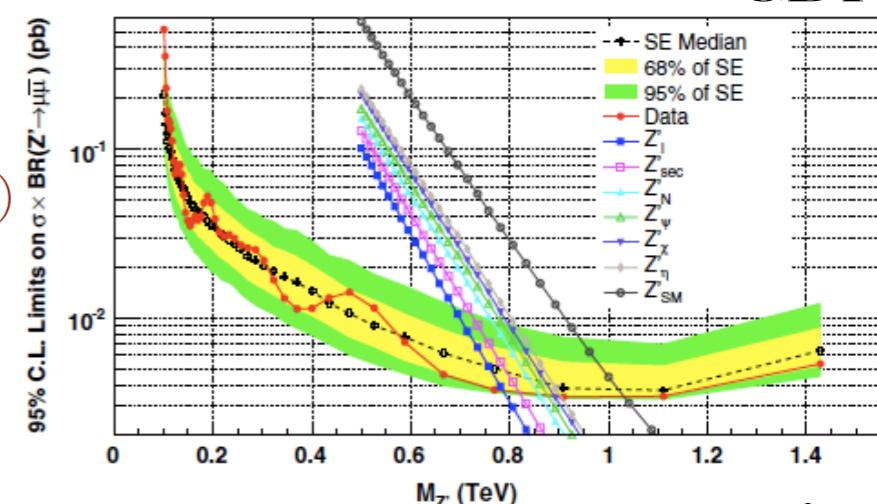
- * Primary issue: statistics



- * Tevatron has best sensitivity to new resonances

- * High-mass resonance searches reaching kinematic limit

- * Improving sensitivity to weakly coupled resonances ($\alpha \lesssim \alpha_{EW}$)

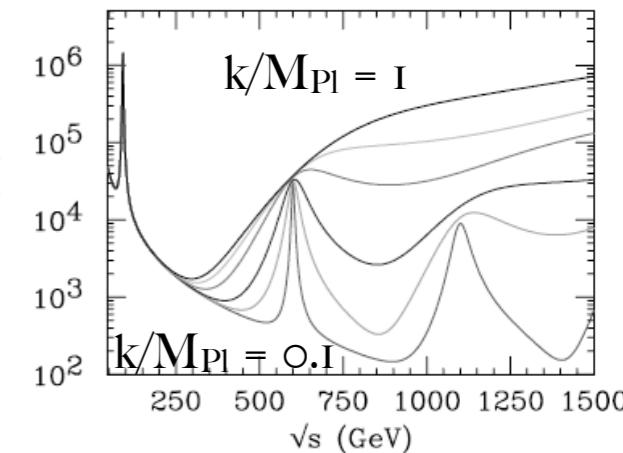


Theoretical motivation

* New neutral resonances ubiquitous in models beyond the SM

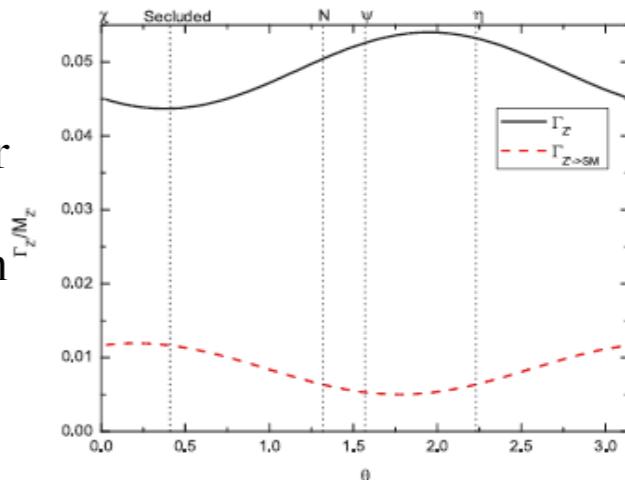
* Spin 2 gravitons in models with warped extra dimensions

- * Randall-Sundrum model: metric contains exponential factor as function of extra dimension
- * Predicts tower of graviton resonances with masses and couplings determined by k/M_{Pl}



* Spin 1 gauge bosons in models with new $U(1)$ gauge group

- * Superstring-inspired grand unified theory ($E_8 \times E_8$): couplings determined by one parameter
- * Stueckelberg model where Abelian gauge boson acquires mass without a Higgs mechanism
- * $U(1)$ with flavor-dependent charge

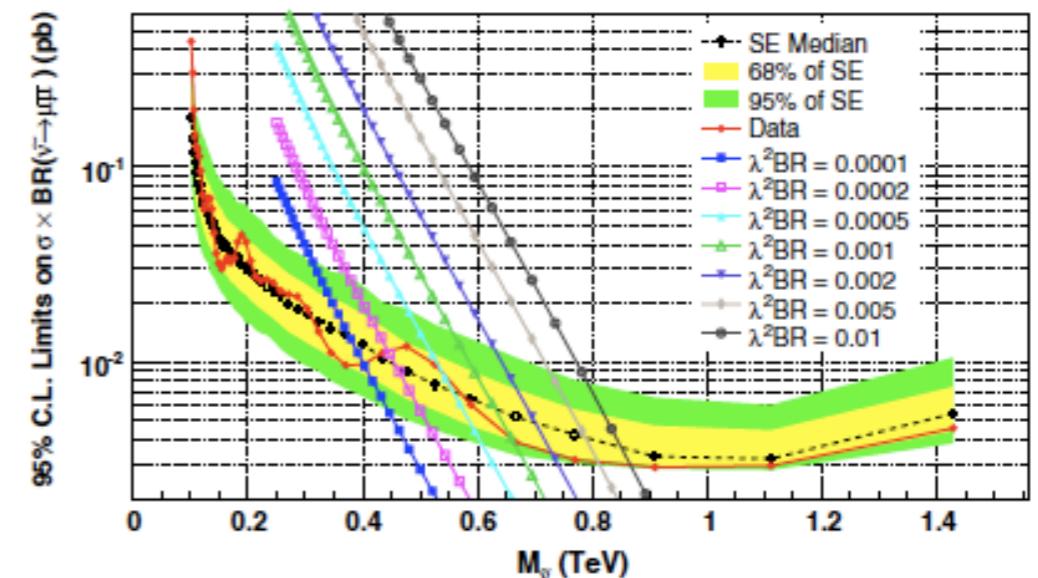
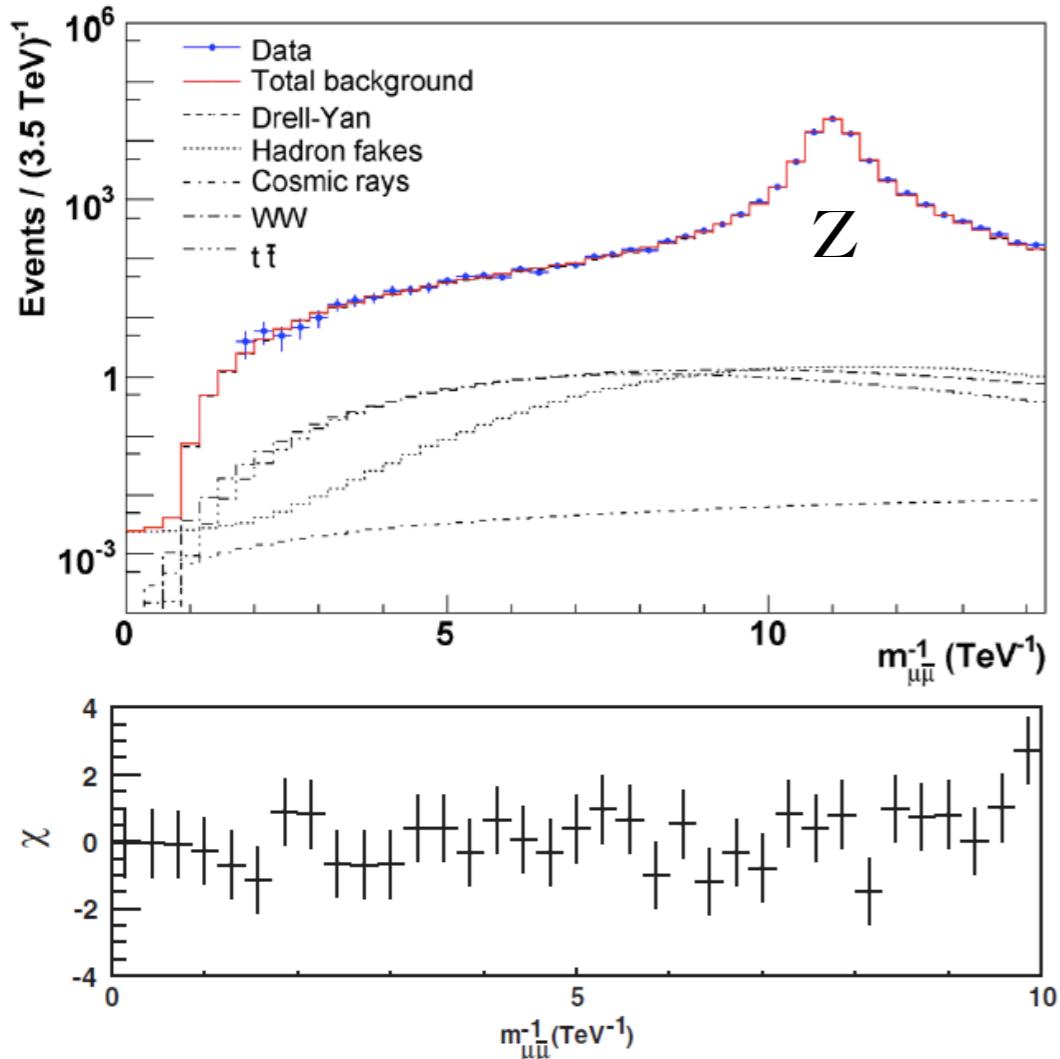


* Spin 0 Higgs bosons and sneutrinos in supersymmetric models

- * R-parity-violation models allow direct q-q-sneutrino and l-l-sneutrino couplings
- * Conserves baryon number, allowing greater suppression of proton decay than R-parity

CDF searches in ee and $\mu\mu$

- * CDF search in 2.3 fb^{-1} of $\mu\mu$ data gives best published sensitivity to sneutrino and Z' production
- * Uses novel method of fitting I/m distribution, which is \approx constant in resolution



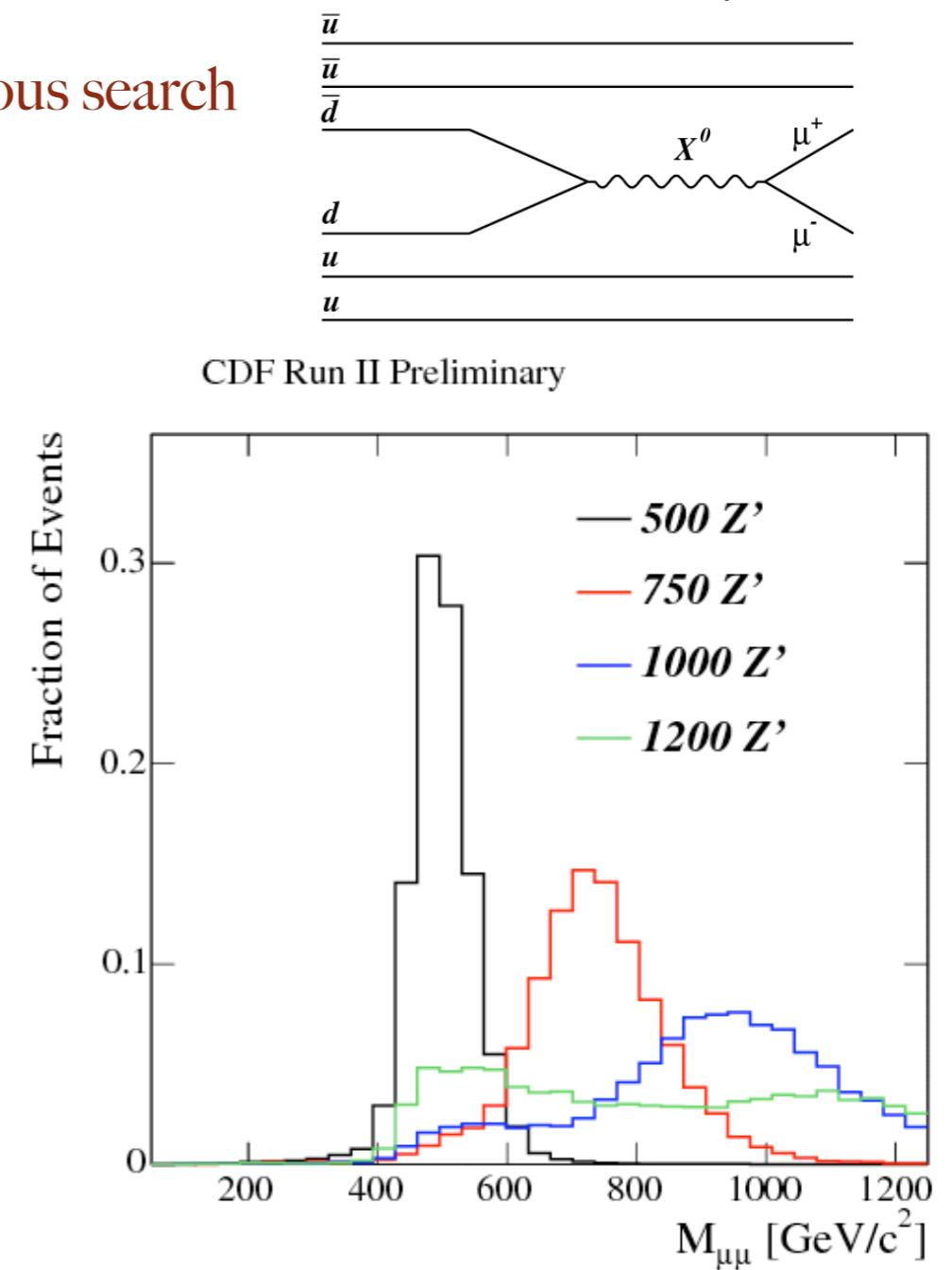
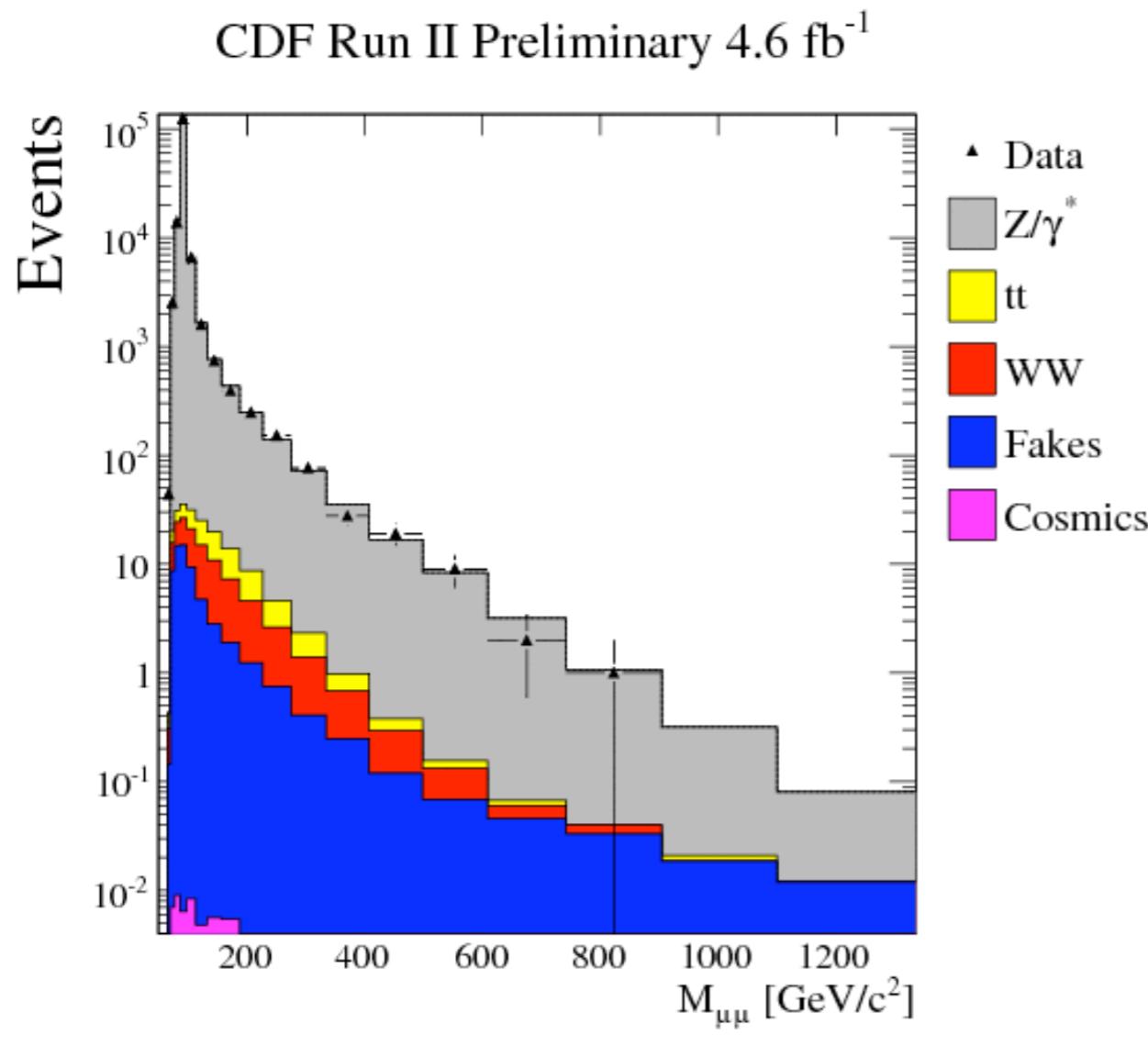
Z' Model	Z' Mass limit	RS graviton k/M_{Planck}	Graviton Mass limit	$\bar{\nu}$ $\lambda^2 \text{BR}$	$\bar{\nu}$ Mass limit
Z'_I	789	0.01	293	0.0001	397
Z'_{sec}	821	0.015	409	0.0002	441
Z'_N	861	0.025	493	0.0005	541
Z'_ϕ	878	0.035	651	0.001	662
Z'_X	892	0.05	746	0.002	731
Z'_η	904	0.07	824	0.005	810
Z'_{SM}	1030	0.1	921	0.01	866

Phys. Rev. Lett. 102, 091805 (2009)

- * CDF ee search finds excess at 240 GeV with 2.5σ significance

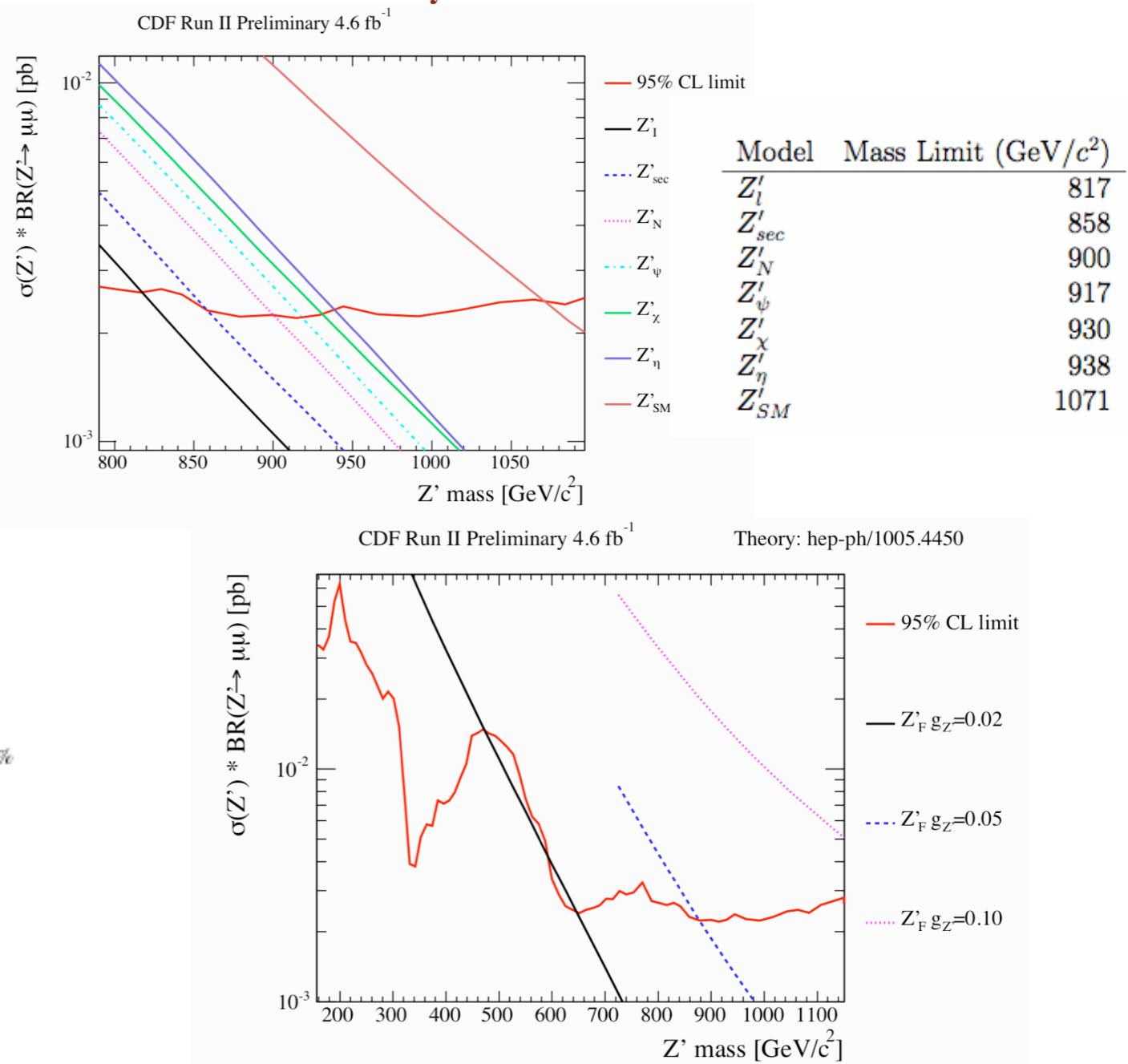
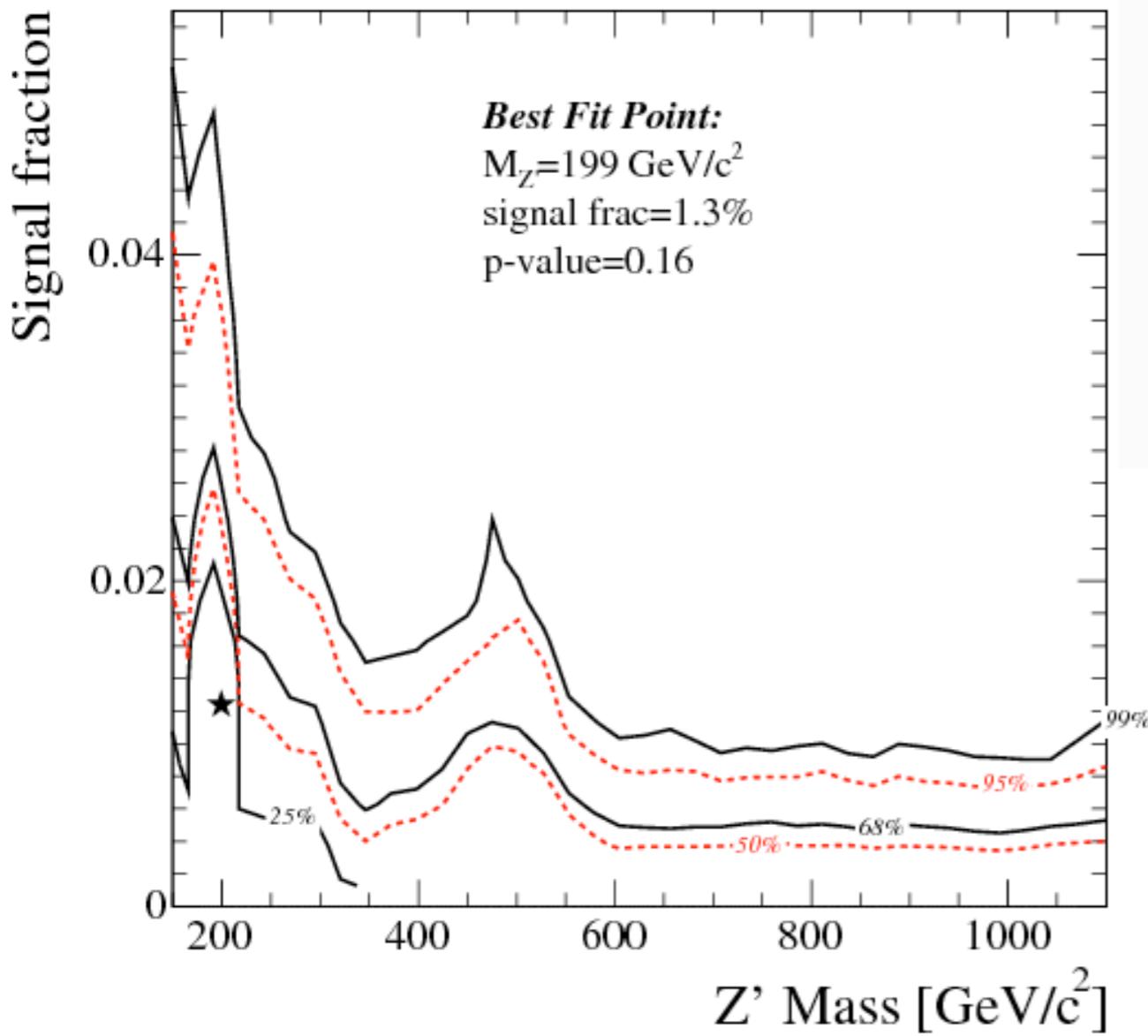
CDF 4.6 fb⁻¹ search in $\mu\mu$

- * New CDF search uses matrix-element-based likelihood to separate Z' signal from Drell-Yan and maximize sensitivity
- * Gains 20% in cross section sensitivity relative to previous search



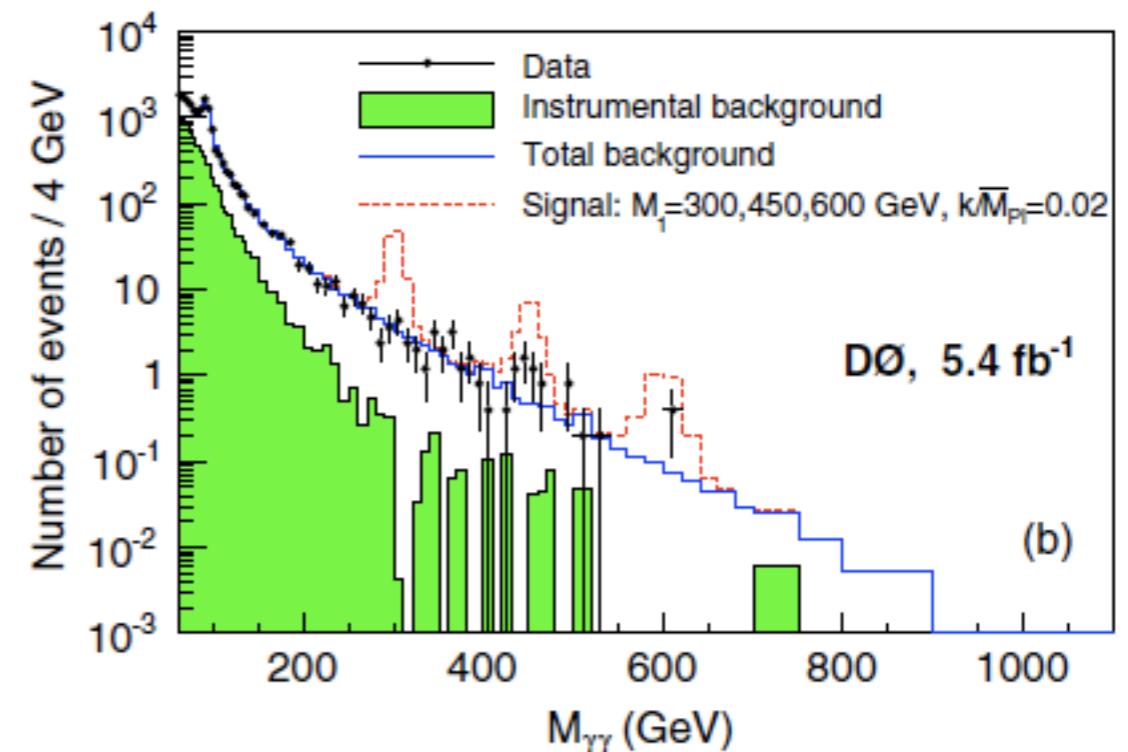
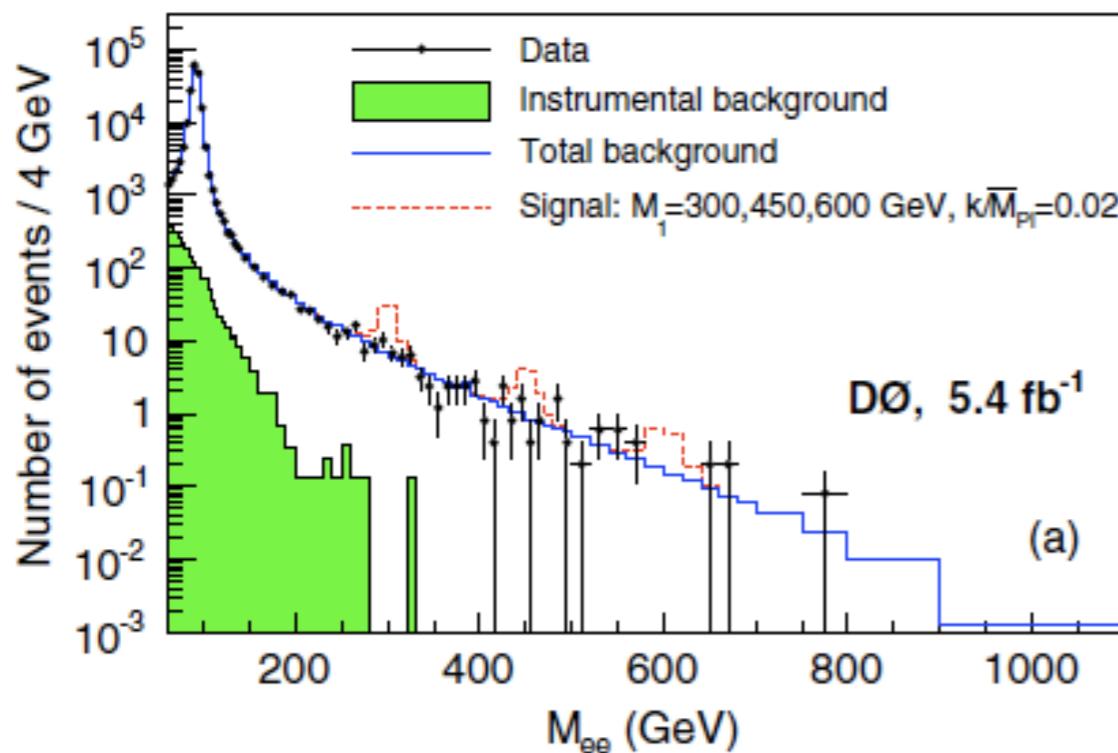
CDF 4.6 fb⁻¹ search in $\mu\mu$

- * Determines best fit to data in cross section vs mass plane
- * Feldman-Cousins contours account for 'look elsewhere' effect by construction

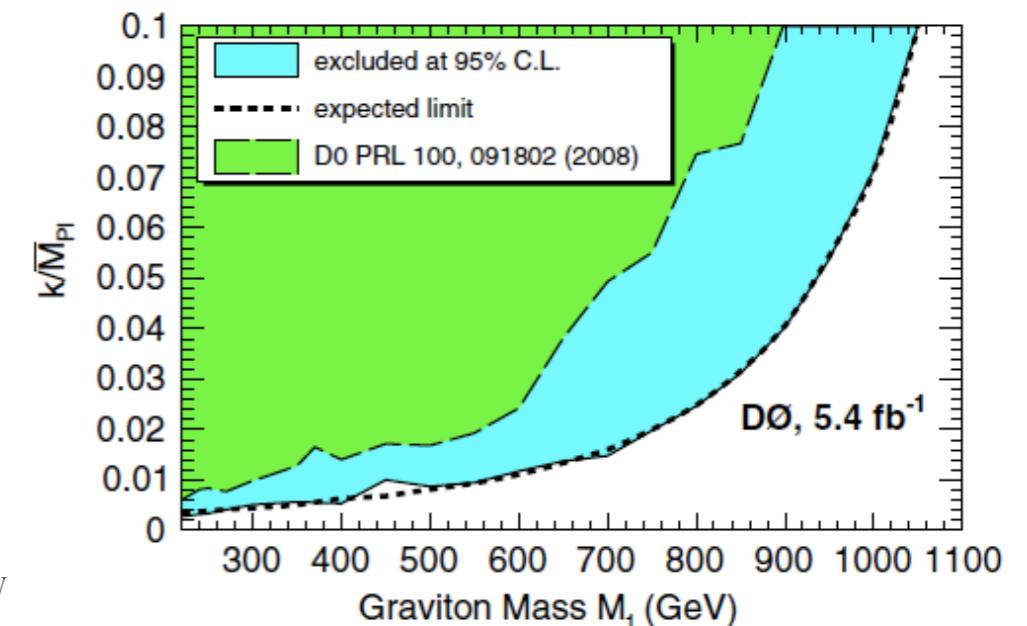


DØ combined ee/ $\gamma\gamma$ search

- * Graviton branching ratio to photons twice that of electrons
- * Gain sensitivity by separately searching dielectrons and diphotons

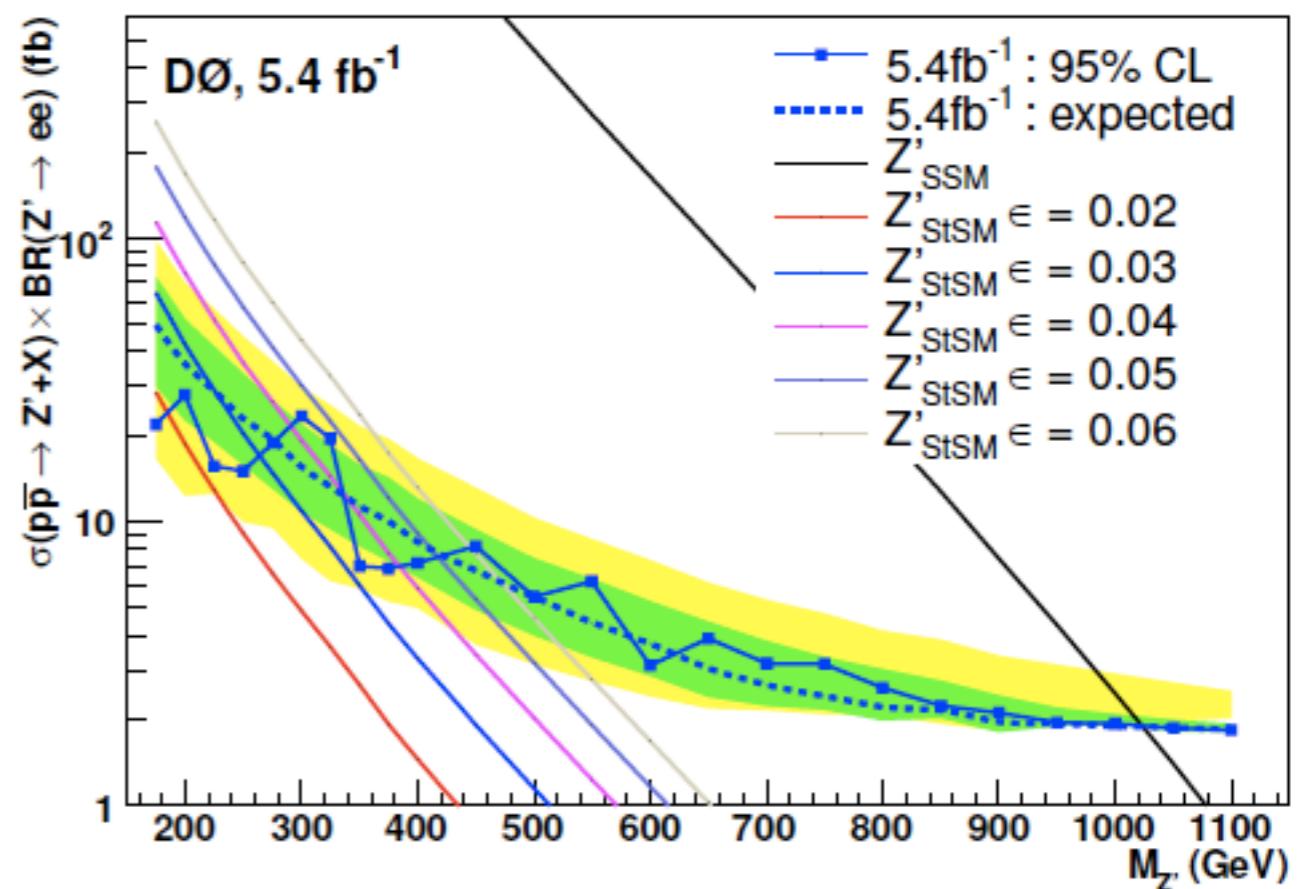
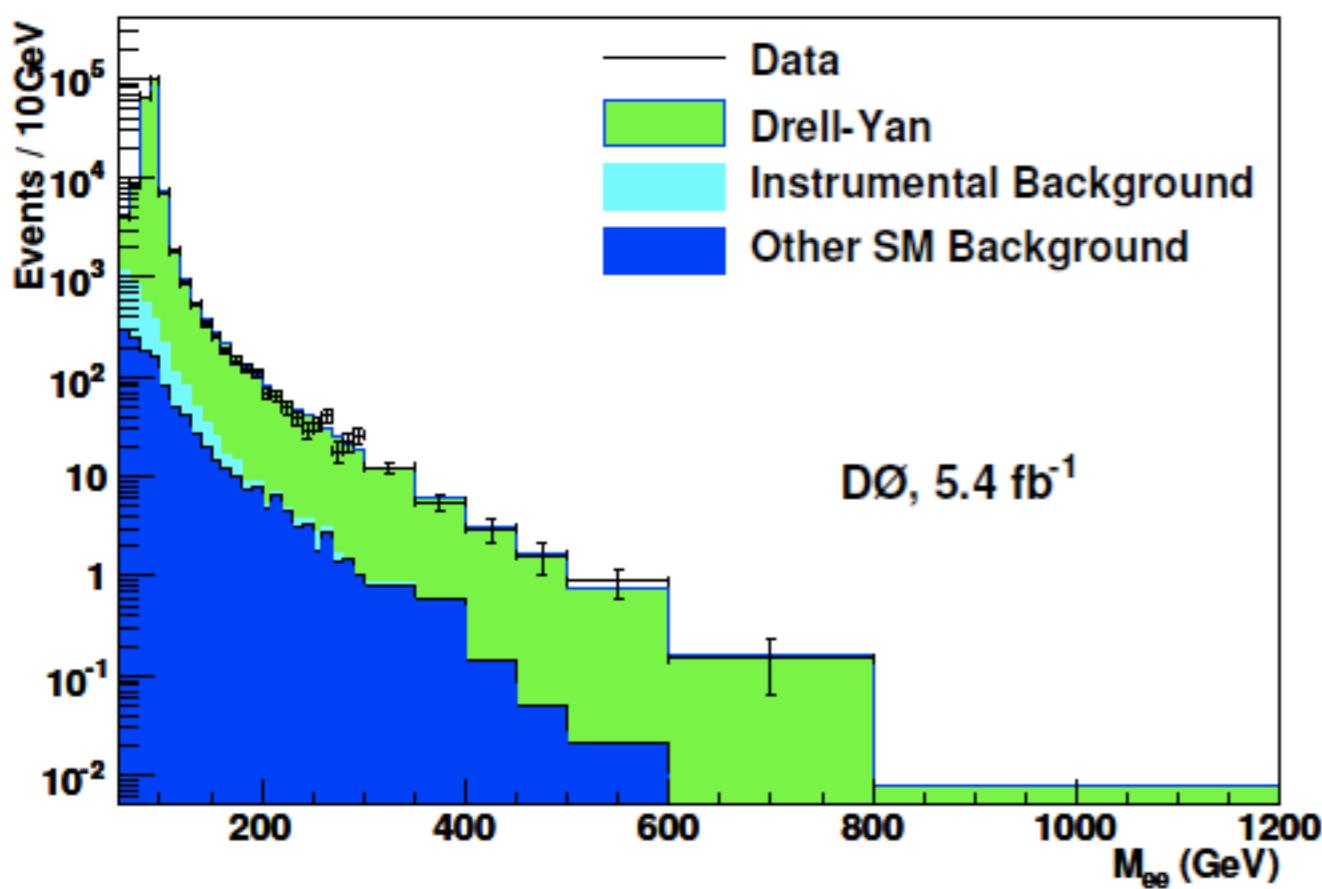


- * Most significant excess at mass of 450 GeV in $\gamma\gamma$
 - * 2.3σ after accounting for mass scan
 - * Not confirmed in dielectrons
- * Set world's highest mass limits on R-S gravitons
Phys. Rev. Lett. 104,
241802 (2010)



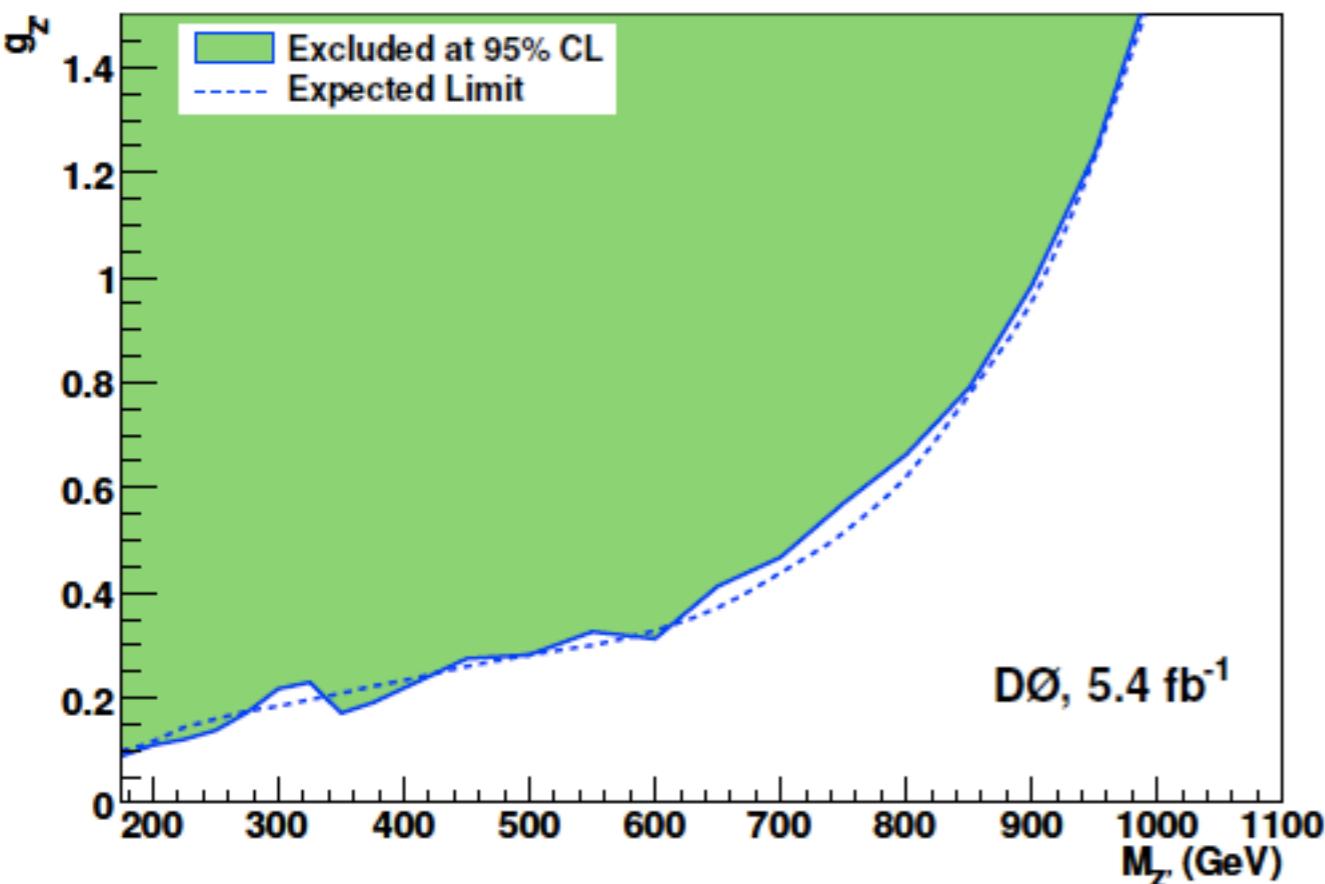
DØ ee search

- * Use dielectron data to probe for Z' bosons
- * Z' with non-universal flavor couplings has higher branching ratio to electrons than muons
- * Test CDF excess at mass of 240 GeV



DØ ee search

- * Set limits on gauge coupling in superstring inspired E_6 model as a function of mass
- * Also set mass limits for Stueckelberg Z' bosons with weak coupling to SM



Model	Lower Mass Limit (GeV)	
	Expected	Observed
Z'_{SSM}	1024	1023
Z'_η	927	923
Z'_χ	910	903
Z'_ψ	898	891
Z'_N	879	874
Z'_{sq}	829	822
Z'_I	795	772
$Z'_{StSM}(\epsilon = 0.06)$	471	443
$Z'_{StSM}(\epsilon = 0.05)$	414	417
$Z'_{StSM}(\epsilon = 0.04)$	340	289
$Z'_{StSM}(\epsilon = 0.03)$	227	264
$Z'_{StSM}(\epsilon = 0.02)$	—	180

Summary

- * Tevatron searches for dileptons and diphotons continually expanding sensitivity
 - * Resonances with couplings of order of the SM Z are reaching kinematic limit
 - * Results with 5 fb^{-1} of data per experiment: probing ever weaker couplings
- * Tevatron continues to pioneer new search techniques and probe new models
 - * Matrix-element provides background separation
 - * For weak couplings searches no longer background-free
 - * Covering many Z' models, general mass vs coupling limits
- * More ground still to cover with full Tevatron data set

